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RESEARCH ARTICLE

EFFECT OF OBESITY ON MEDIAN NERVE CONDUCTION AT CARPAL TUNNEL LEVEL IN INDIAN WOMEN

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Median Nerve Conduction; Carpal Tunnel; Nerve Conduction Studies; BMI; Obesity; Distal Motor and Sensory Latencies

Background: Nerve conduction study (NCS) is essential in the diagnosis of focal neuropathies and diffuse polyneuropathies. There are many reasons of variations in nerve conduction velocity (NCV). Age, height, and body mass index (BMI) can affect NCVs, as reported by previous studies. It has been documented that obesity affects NCV.
Aims & Objective: In this study, we tried to find the effect of obesity on median nerve conduction at carpal tunnel area in healthy Indian women.
Materials and Methods: Women with age group between 25 and 64 years with BMI <25 and >25 were divided into non-obese and obese groups, respectively. Wrist ratio and wrist/palm ratio were measured. NCS was carried out for median and ulnar nerves on bilateral hands. Ulnar nerve study was carried out to rule out peripheral neuropathy.
Results: The differences in distal motor and sensory latencies between obese and non-obese groups were found to be statistically significant ($P < 0.05$). There was statistically significant difference in wrist ratio between the two groups; however, there was no statistically significant difference in wrist/palm ratio.
Conclusion: It can be concluded that obesity causes increase in sensory and motor latency of median nerve at carpal tunnel area in women. Increased wrist ratio is also an independent risk factor in delayed median nerve conduction.

INTRODUCTION

A nerve conduction study (NCS) is a neurological test that evaluates the conduction of electrical impulses down to peripheral nerves. Because nerves conduct signals at a standard speed and amplitude, diseases of the nerves that may alter these impulses can be detected by measuring these signals. The nerve conduction test provides information about the functioning of the peripheral nerves including both the type of dysfunction and the likely location of its cause. This can be used to help diagnose various diseases that impact the nerves, for example, peripheral nerve tumors, neuropathies, traumatic nerve injuries, nerve entrapments (such as carpal tunnel syndrome, CTS), and various diseases of the spine. The NCS consists of motor and sensory NCSs.

Motor NCSs are performed by applying electrical stimulation to a peripheral nerve and recording the evoked response from a muscle supplied by this nerve. The time it takes for the electrical impulse to travel from the stimulation site to the recording site is measured. This value is called the latency and is measured in milliseconds (ms). The size of the response—called the amplitude—is also measured. Motor amplitudes are measured in millivolts (mV). Sensory NCS are performed by applying electrical stimulation near a peripheral nerve and recording the evoked response from a purely sensory portion of the nerve, such as on a finger. The recording electrode is more proximal of the two. Like the motor NCSs, sensory latencies are on the scale of milliseconds (ms). Sensory amplitudes are much smaller than the motor amplitudes and are usually in the microvolt (μV) range.

The prevalence of obesity is increasing worldwide, with current estimates suggesting that there are more than 300 million obese adults.[1] Letz and Gerr found the relationship between obesity and slow conduction of the median nerve across the wrist in a large cross-sectional study, but an inverse relationship was found between obesity and other peripheral nerve measures. Conduction velocity (CV) of the peroneal, sural, and ulnar nerves all tended to improve among subjects who were more obese, and only the median sensory nerve across the wrist showed slowing.[2]

The differential nerve responses to obesity suggest that the carpal tunnel has a unique effect on the median nerve in response to increasing body mass index (BMI).

There are many studies that evaluate the effect of specific personal factors such as age, height, and BMI on nerve velocities. However, the majority of these studies are carried out on Caucasian subjects. Therefore, this study is designed to study the effect of one specific factor—obesity (BMI)—on conduction of median nerve among female subjects in India.

The present study was conducted to explore whether obesity have effect on the median nerve conduction at carpal tunnel area in Indian women.

MATERIALS AND METHODS

Overview

This prospective study was carried out at the Department of Physical Medicine and Rehabilitation of All India Institute of Physical Medicine and Rehabilitation (AIIPMR), Haji Ali, Mumbai. Women only between 25 and 64 years were included in the study. Subjects with concomitant diseases (such as history of diabetes, thyroid disease), history of cervical radioculopathy, previous carpal tunnel surgery or inflammatory wrist disease, upper extremity fracture, history of numbness, paresthesia and/or pain either only nocturnal or diurnal and nocturnal in the median nerve distribution, and history of median motor and sensory deficit were excluded from the study. The study was approved by the ethics committee and informed consent was taken from each subject before the commencement of the study.

Subjects were classified in two groups—obese and non-obese—based on BMI, a general indicator of the body fat content that was calculated by dividing the body weight in kilograms by height in meters squared. Subject's height was measured and weighed without shoes. Subjects who had BMI of ≥25 were classified as obese and <25 as non-obese.

Measurements of wrist ratio and wrist/palm ratio were performed using an engineering caliper. Wrist ratio was obtained by dividing the anteroposterior dimension of the wrist (wrist depth) by its mediolateral dimension (wrist width), as shown in Figures 1 and 2.

Wrist/palm ratio was obtained by dividing the depth of the wrist by the length of the palm. Palm length was measured from the base of the middle finger to the level of the distal flexion crease of the wrist, as shown in Figure 3. It was taken as an index for the size of the hand; small hands have shorter palm length but larger wrist/palm ratio.

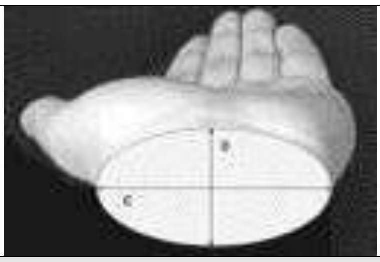

Figure 1: External wrist dimensions: (C) Wrist width, (D) wrist depth

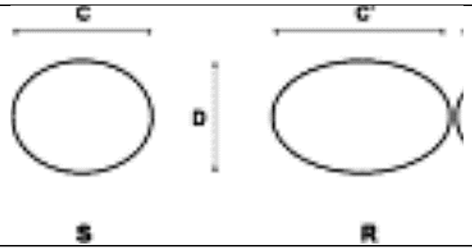

Figure 2: Wrist ratio: D/C. (S) Square wrist, (R) rectangular wrist

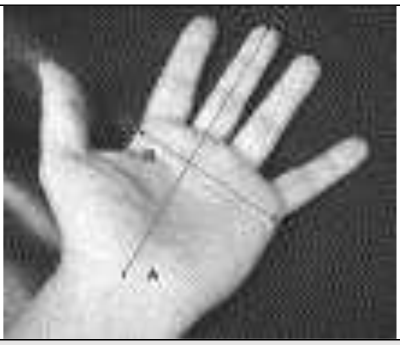

Figure 3: Palm length

Nerve Conduction Studies

Nerve conduction studies were performed on all 30 subjects using Sierra II EMG/EP System for the median and ulnar nerves of both the hands at the wrist level. Ulnar nerve study was conducted to rule out peripheral neuropathy. Both motor conduction study (median and ulnar amplitudes and their motor distal latencies) and sensory conduction study (median and ulnar amplitudes and their sensory latencies by antidromic stimulation) were conducted.

Surface electrodes were used. The recording electrodes were fixed to the subject's skin using adhesive tape. The temperature of the room was maintained at 21–23 °C. The temperature of the extremities was maintained at 32 °C. Subjects with abnormalities in ulnar-nerve motor and sensory conduction were excluded from the study.

Machine Settings: Machine settings for recording of motor and sensory conduction of median and ulnar nerves are given in Tables 1 and 2.

Statistical calculations were performed using unpaired *t*-test for comparing the significance of difference of means of the obese and non-obese groups.

Table 1: Setting for recording of motor conduction of median and ulnar nerves

Parameter	Setting
Sensitivity	2000 µV/division
Low-frequency filter	10 Hz
High-frequency filter	10,000 Hz
Sweep speed	3 ms/diversion
Pulse width	100 µS

Table 2: Setting for recording of sensory conduction of median and ulnar nerves

Parameter	Setting
Sensitivity	20 µV/division
Low-frequency filter	10 Hz
High-frequency filter	2000 Hz
Sweep speed	2 ms/diversion
Pulse width	100 µS

RESULTS

This study was performed on 30 women (15 obese and 15 non-obese) showing no symptoms, with their ages ranging from 27 to 62 years. The basic characteristics of the data set are in Table 3.

Table 3: Personal factors of subject group

Groups	Age	BMI	Wrist Ratio	Wrist/ Palm Ratio
Obese	41.3 ± 9.6	30.6 ± 4.9	0.43 ± 0.03	0.13 ± 0.04
Non-obese	45.5 ± 12.0	21.7 ± 1.6	0.48 ± 0.06	0.15 ± 0.02

Note: The data of the subjects in the table are expressed as the arithmetic mean ± standard deviation.

Table 4: Comparison across obese and non-obese groups in study group

Factors	Obese	Non-obese	*P*-value	*t* Score	Significance
Sample size	15	15			
Age	41.33	45.53	0.300	1.06	NS
BMI	30.60	21.73	0.000	6.60	HS
Wrist ratio	0.43	0.48	0.006	3.06	MS
Wrist/Palm ratio	0.13	0.15	0.182	1.38	NS
Distal motor latency, Rt (ms)	3.04	3.62	0.000	4.20	HS
Distal motor latency, Lt (ms)	3.04	3.59	0.000	4.22	HS
Motor amplitude, Rt (mV)	7.15	7.13	0.958	0.05	NS
Motor amplitude, Lt (mV)	6.93	6.92	0.975	0.03	NS
Distal sensory latency, Rt (ms)	2.72	2.99	0.008	2.84	MS
Distal sensory latency, Lt (ms)	2.72	2.94	0.017	2.55	S
Sensory amplitude, Rt (ųV)	44.36	37.03	0.057	2.01	NS
Sensory amplitude, Lt (ųV)	45.11	38.23	0.065	1.97	NS

Statistical calculations were performed using unpaired *t*-test for comparing the significance of difference of the means of the obese and non-obese groups. The key parameters across the two groups and statistical results are given in Table 4.

As seen from Table 4, the differences in the means of distal motor latencies and distal sensory latencies between the obese and non-obese groups are statistically significant with *P*-values being <0.05. However, the differences in the means of sensory and motor amplitudes between the obese and non-obese groups are not statistically significant with *P*-values >0.05. Mean of wrist ratio scores of obese and non-obese groups were 0.43 (0.03) and 0.48 (0.06), respectively. Statistical difference between the means of various parameters such as age and wrist/palm ratio was not significant.

Following are the salient features of this study:

- Obesity causes delay in distal sensory and motor latency of median nerve in asymptomatic obese (BMI ≥25) vs. non-obese (BMI <25) subjects.
- Wrist ratio should be taken into consideration while interpreting NCS.
- Obesity did not have effect on sensory and motor amplitude of median nerve.

DISCUSSION

Nerve conduction study is an important method used in clinical practice and has been thoroughly validated. Many studies and reviews on NCS have been published. These include the factors that affect nerve velocities. These factors can be divided into biological factors (age, height, gender) and physical factors associated with the physical state of the nerve and muscle.

In a study conducted among healthy Malaysian population, Awang et al.[3] observed slowing of CV with increasing BMI in the median nerve (motor and sensory) and peroneal nerves. They also have noticed no observable trend in sensory ulnar nerve CV. The present study concluded that obesity result in increased distal sensory and motor latency of median nerve in healthy Indian women.

Radecki[4] found that prolongation of median latencies were associated with increased BMI regardless symptoms were considered related to work or not. Nathan et al.[5], in a longitudinal study of the etiology of CTS in industrial workers, found a highly significant increase in average BMI in female workers presenting with median slowing after 5 years of follow-up. BMI is an important risk factor for slowing of median nerve sensory conduction in industrial workers and a useful predictor for those who would subsequently develop slowing (5 years study). The present study observed the role of obesity in delayed distal sensory and motor latency in obese group.

Buschbacher studied the role of BMI on nerve amplitude in normal subjects and found that increase in BMI correlates significantly with reduced sensory and mixed nerve amplitudes.[6] A study by Hasanzadeh et al.[7] showed that among physiological factors of sex, height, BMI and finger size, skin thickness is the best predictor of sensory nerve action potential amplitude (SNAP-A). It has been shown that finger circumference negatively correlates with SNAP-A. Also, obese people have lower sensory nerve amplitudes. However, the present study failed to correlate obesity with sensory nerve amplitude.

Katharyn et al.[8] studied effects of age and weight on the measurements of motor nerve conduction time in an asymptomatic population of industrial workers. Motor nerve conduction time was found to be increased with age, length of employment, and weight. The present study also shows delayed motor conduction in obese group.

Johnson et al.[9] observed that the squarer the wrist, the longer the median sensory latencies. In the present study, it is observed that increased wrist ratio and BMI are risk factors in delayed median nerve conduction. However, our study could not prove the effect of wrist/palm ratio on median nerve conduction.

Werner et al.[10] observed that obese individuals have slowed conduction in median nerve across the wrist. They observed a strong correlation between median nerve conduction slowing and median nerve cross-sectional area at the wrist but concluded that obesity does not influence carpal canal pressure or size of median nerve at the wrist. The findings of the present study show that obese individuals have slowed conduction in median nerve across the wrist but do not directly suggest that excess body weight can result in symptoms.

Werner et al.[11] studied prolonged median sensory latency as a predictor of future CTS and found that among subjects with abnormal median sensory latencies, 23% went on to develop symptoms consistent with CTS within the follow-up period, compared with 6% in the control group ($P = 0.010$). The results of the present study were consistent with the previous studies that have suggested the role of obesity in delayed sensory and motor latency in obese group. However, we could not comment on when these subjects are likely to develop symptoms because of short duration of the study period.

CONCLUSION

It can be concluded that obesity causes increase in sensory and motor latency of median nerve at carpal tunnel area in women. Increased wrist ratio is also an independent risk factor in delayed median nerve conduction.

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